the general science journal

A more technical approach to the William Bertozzi[1] and Liangzao Fan[2] experiment, or how Bertozzi‘s measurements refutes special relativity

by

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Abstract:

A technically nonlinear approach is made to fit **measured** Time of Flight data into an easy and understandable function without postulates. Only one assumption is made, namely that the impact of energy and so the connected force on a particle with charge e is decreasing and going to zero if the velocity enters the magnitude of c, the velocity of light. A sight behind the curtains reveals that the H. A. Lorentz function is a good approximation of the found data up to v/c ~ 0,95, but is not able to predict the measurements precisely of Bertozzi in the relativistic area.

Keywords: Bertozzi, Liangzao Fan, Zürich, relativistic electron, *(c-v)*-behaviour, Lorentz, Time of Flight, special relativity, accelerated charge, Linac

§1 deducing a nonlinear function out of measured datapoints

In 1964 William Bertozzi made a really remarkable experiment for educational reasons. Up to this time it was the first setup to measure the time of flight (ToF) of accelerated particles (electrons) directly with the help of an Oscilloscope. He used an 100 Mhz Tektronix Oscilloscope Type 581, wich was state of the art during this time. The accelerated charges were measured at the beginning and at the end of a S=8,4 m drift path. Through the simple division of S by ToF the corresponding velocities were calculated. A linear acceleration unit (linac) with three stages was used. The first stage was an van der Graaff generator with a maximum energy of 1,5 MeV. Second stage utilized energies of 3 MeV. The last and third stage could provide 15 MeV. The drift space with energies up to 1,5 MeV was 8,4 m. At 4,5 MeV level the particles were accelerated roughly 1 m within the drift space, so that about 7,4 m was without acceleration. And at a level of 15 MeV the particles were accelerated all the time within the drift space.

Liangzao Fan repeated these measurements later on a lower energy level. Both Bertozzi and Liangzao Fan made caloric measurements too. Addionally Bertozzi and Liangzao Fan measured the amount of charge per Burst through a capacitor. The results are shown in Table 1.

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Table 1 ToF observed

Run	eU/mc^2	ToF obs.	v/c obs.	E_{cal}/mc^2	Remark
Number	-	*10-8 sec	-	-	
a	0,0491	8,9519	0,313	-	Liangzao Fan
b	0,0687	7,5933	0,369	-	Liangzao Fan
c	0,0883	6,8008	0,412	-	Liangzao Fan
d	0,1080	6,2404	0,449	-	Liangzao Fan
e	0,1276	5,8374	0,480	-	Liangzao Fan
f	0,978	3,23	0,8675	-	Bertozzi
g	1,957	3,08	0,9097	-	Bertozzi
h	2,935	2,92	0,9596	3,24	$3{,}81 \cdot 10^{13}$ Particles per Burst
i	8,806	2,84	0,9866	9,42	Bertozzi
j	29,353	2,80	1,0007*	-	Bertozzi, v > c
k	11,78	-	-	1,18	Liangzao Fan
l	15,70	-	-	1,42	$2{,}36 \cdot 10^{13}$ Particles per Burst
m	19,63	-	-	1,51	Liangzao Fan
n	23,56	-	-	1,61	Liangzao Fan
o	29,45	-	-	1,65	Liangzao Fan

* adjusted to v/c = 0,996 according to a ToF of $2{,}813 \cdot 10^{-8}$ sec yielded from the 1/x-function with the stastically derived k because Bertozzi‘s value of v/c = 1,0007 extends the speed of light. Bertozzi‘s value is slightly over the velocity of light. At velocities of v/c ~ 1 $E_{kin\ srt}$ is infinite and relativistic mass is also infinite. The consequense of this is that such particles if infinitive in energy and mass could not be stopped. So a test must be made to deaccelerate particles with velocities close or nearly equal to c.

According to this investigation mass $m = m_0$ remains constant. E_{cal}/mc^2 denotes the caloric energy per particle. As seen from Table 1 the caloric measurements are difficult. Bertozzi has roughly 10% more than the Linac‘s input, while Liangzao Fan measured 1/10 of the Linac‘s working energy. As in mainstream physics (1964) usual Bertozzi indicates eU/mc^2 as E_k in accordance with the relativistic energy equation. As one can see Table 1 (ToF obs.) clearly shows an asymptotical approach to the limit of ToF = s/c = 28,02 nsec, where s=8,4 m is the drift space and c is the velocity of light.

Thus ToF can be described as an 1/x Function with a limit of 28,02 nsec. No further assumptions are nessecary and needed.

The Time of flight observed is shown in figure 1

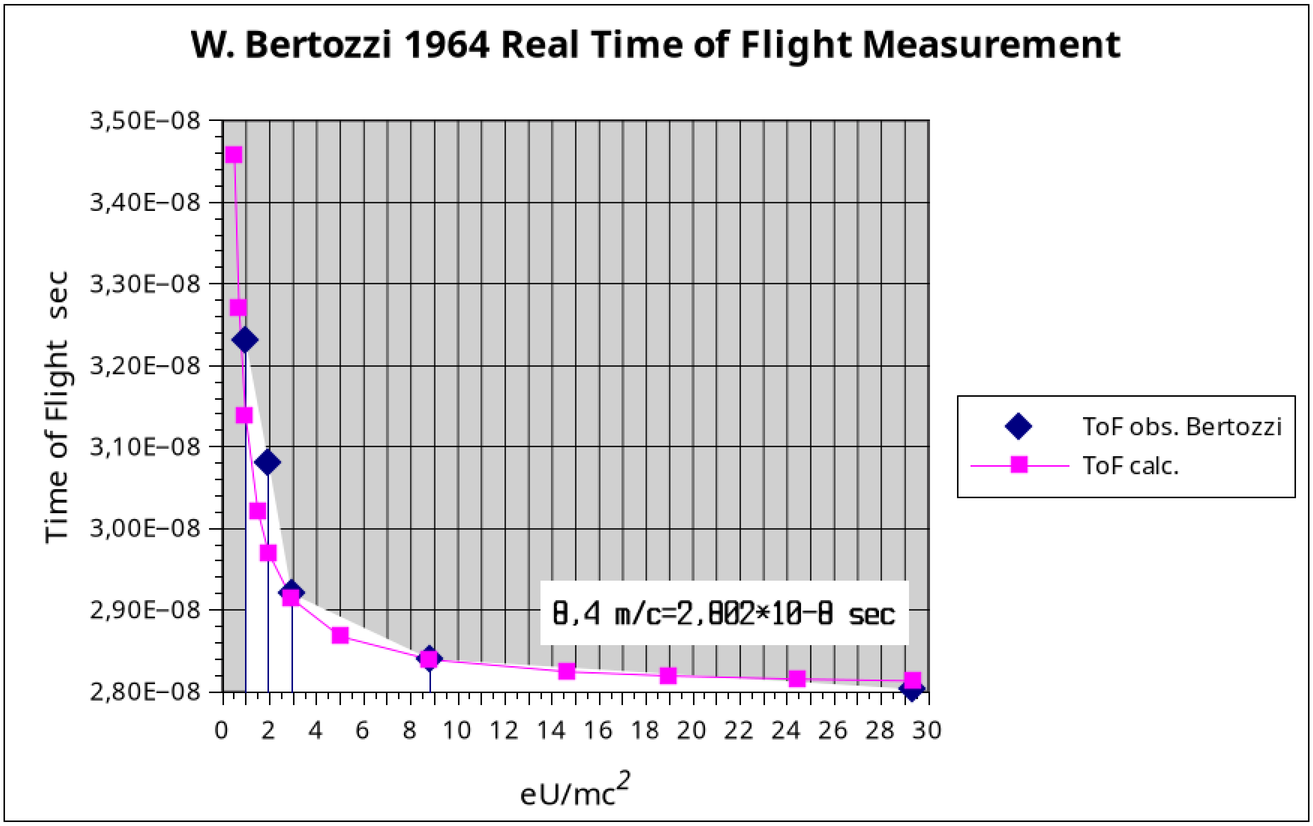

Figure 1: ToF observed and calculated with a 1/x-function

As one clearly can see ToF has a limit and increasing energies do not result in ToF lower than 28,02 nsec. This is a typical 1/x function.

Through the simple Ansatz

$$ToF = s/v = k/(eU/m_0c^2) + s/c \quad (1)$$

with s is 8,4 m (drift space in the Bertozzi setup), v is the velocity of the accelerated particle, c is the velocity of light, eU denotes the working energy of the linac, m_0 the mass of a particle under question and k a konstant to be stastically determined.

And with 10 datapoints (to less!) of ToF and eU and with the help of the least square method (nonlinear regression), we yield:
$k=3{,}28*10^{-9}$ sec. The inverse value of the velocity c is $3{,}33*10^{-9}$ sec/m, so k is not far away from that. With more datapoints k could just be that value.

Rearranging equation (1) to obtain v/c yields:

$$\beta = v/c = [k\cdot c/s\cdot(m_0c^2/eU) + 1]^{-1} \quad (2)$$

Figure 2 shows a plot of v/c against eU/m_0c^2 together with the observed values of Bertozzi and the relativistic expression.

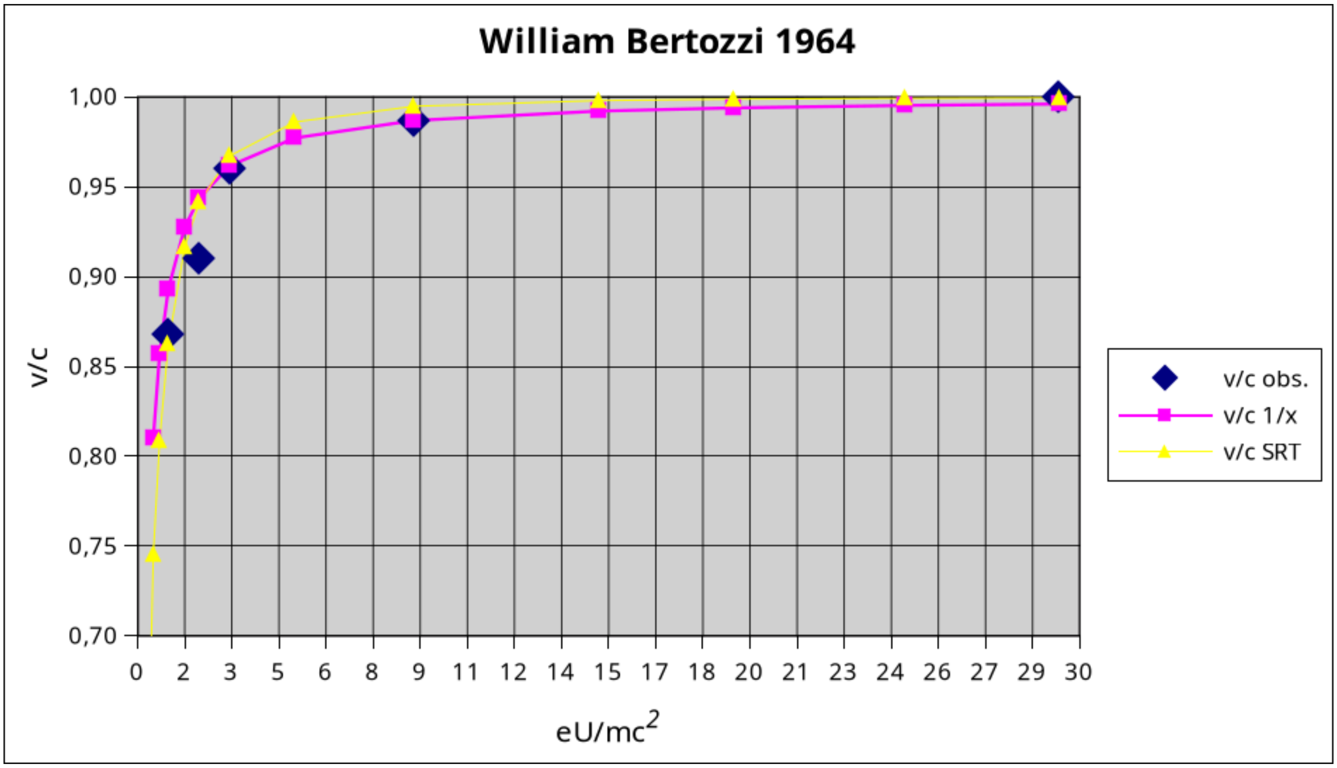

Figure 2: v/c observed and calculated with an 1/x-function and the relativistic expression.

Both calculated curves are excellent approximations of the observed values on the first sight. In the range from $eU/m_0c^2 = 3$ to 30 the Lorentz-curve is always higher than the observed and calculated 1/x-values. A kind of pivot is around $eU/mc_0^2 = 3$, so that for values $eU/mc_0^2 < 3$ the values of the relativistic curve are slightly lower than the 1/x-plot.
The interpretation of equation (2) is simply: eU must be infinite to reach v/c = 1. So with all linear acceleration units it will be never possible to accelerate a particle (with mass) to the speed of light. This implies that the impact of energy or force must decrease with v/c. This is contrary to the action at a distance educated in schools and universities. Today it is common sense that all electro-magnetic fields propagate with the speed of light. Why not energies or forces?

If we rearrange again equation (1) to obtain eU on the left side, we get:

$$eU\cdot(1-\beta) = F\cdot(1-\beta)\cdot s_{a=}\, m_0c^2\cdot k\cdot c/s\cdot\beta \qquad (3)$$

where $v/c = \beta$, F is the force working on a particle within a path of s_a (s_a is not s!).
Hence we obtain with $p_0 = m_0\cdot c\cdot k\cdot c/s$, p_0 maybe an intrinsic momentum of one particle.

$$eU - \beta\cdot eU = p_0\cdot v \qquad (4)$$

Equation (4) might be interpreted as follows:

input linac energy – wasted linac energy yields kinetic energie.

hence

$$I - W = E_{kin} = p_0 \cdot v \qquad (5)$$

Equation (4) or (5) is understandable: if v = 0 then E_{kin} = 0 so eU = 0. And if v is entering the area of c then I-W and consequently E_{kin} are going to zero. So no further acceleration. So E_{kin} is always finite. Equation (4) explains why there is no further acceleration. It is simply because force and/or energy can not act faster on particles as with the speed of light. This was the proposal of W. Weber in the 19th century!

To consider all measured datapoints figure 3 shows the combined ToF datapoints of Bertozzi and Liangzao Fan.

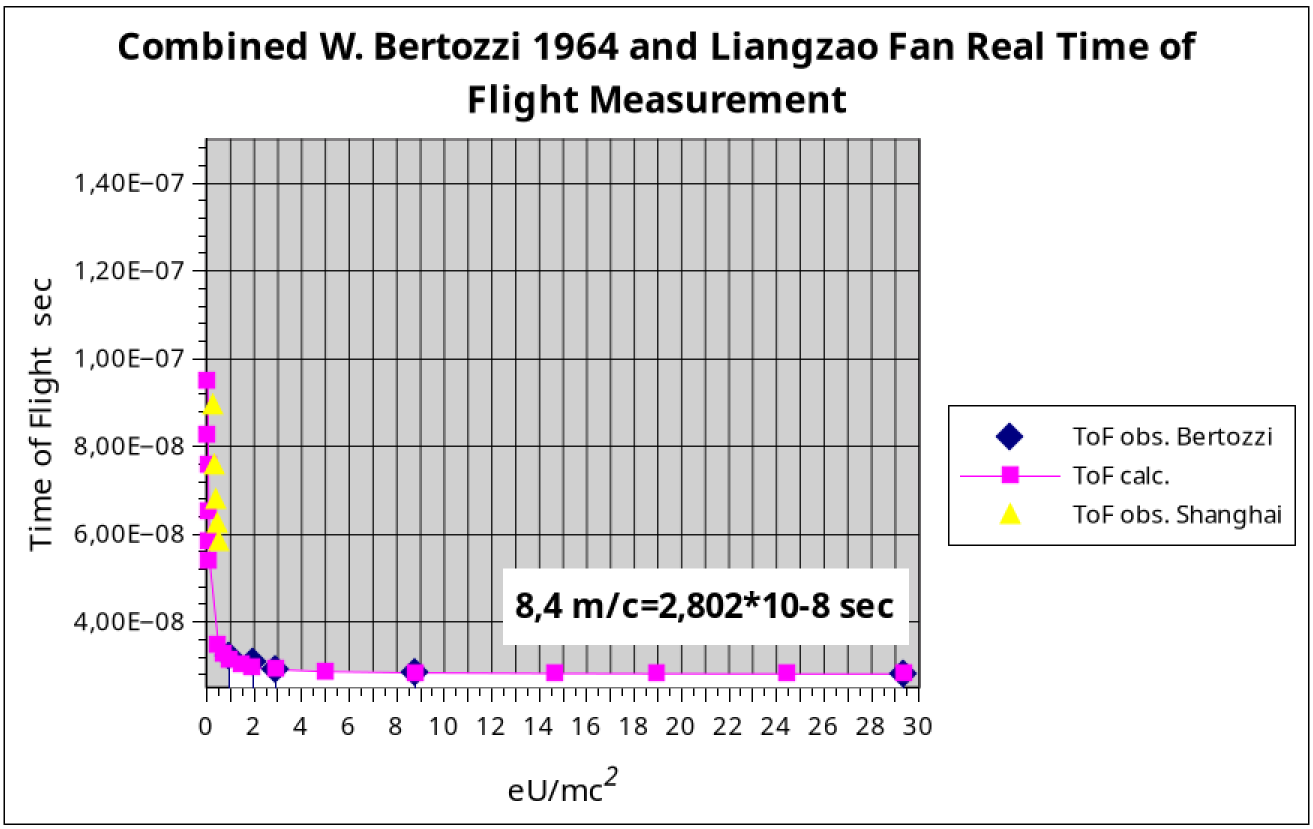

Figure 3 combined ToF (Bertozzi/ Liangzao Fan)

§2 The efficiency or COP of a linac.

The coefficient of performance (cop) or the efficiency of a linac can be described as follows. The kinetic energy derived from the effective input energy (at $v = v_1$) divided by the nominal (at v = 0) input energy is the efficiency of a linac.
Hence:

$$\eta = cop = E_{kin}/eU \tag{6}$$

from equ. (4 and 5) we obtain:

$$\eta_{1/x} = eU(1 - \beta)/eU = 1 - \beta \tag{7}$$

Equation (7) is always lower than 100 %.

According to relativity theory cop of a linac must be always 100%, because all linac's input energy is converted or given to kinetic energy of a particle regardless of particles velocity (action at a distance).
So:

$$\eta_{srt} = E_{kin\ srt}/eU = 1 \tag{8}$$

A summary of the cop or efficiency of a linac is given in Table 2 below

Table 2 COP or Efficieny of a Linac						
eU/mc^2	**E_{cal}/mc^2 obs.**	**E_{cal}/eU obs.**	**v/c**	**COP_{SRT}**	**$COP_{1/x}$**	**Remark**
0,05	-	-	0,313	1,078	0,687	Liangzao Fan v/c obs.
0,07	-	-	0,369	1,105	0,631	Liangzao Fan v/c obs.
0,09	-	-	0,412	1,103	0,588	Liangzao Fan v/c obs.
0,11	-	-	0,449	1,104	0,551	Liangzao Fan v/c obs.
0,13	-	-	0,48	1,096	0,520	Liangzao Fan v/c obs.
0,98	-	-	0,8675	1,033	0,132	Bertozzi v/c obs.
1,96	-	-	0,9097	0,720	0,090	Bertozzi v/c obs.
2,94	3,24	1,104	0,9596	0,870	0,040	Bertozzi v/c obs., E_{cal} obs.
8,81	9,42	1,070	0,9866	0,582	0,013	Bertozzi v/c obs., E_{cal} obs.
11,78	1,18	0,1003	0,9902	-	-	Liangzao Fan E_{cal} obs.
15,70	1,42	0,0903	0,9926	-	-	Liangzao Fan E_{cal} obs.
19,63	1,51	0,077	0,9941	-	-	Liangzao Fan E_{cal} obs.
23,56	1,61	0,068	0,9951	-	-	Liangzao Fan E_{cal} obs.
29,35	-	-	0,9996	1,171	~0	Bertozzi v/c obs.
29,45	1,65	0,056	0,9960			Liangzao Fan E_{cal} obs.

Figure 4 showes the outcome of table 2

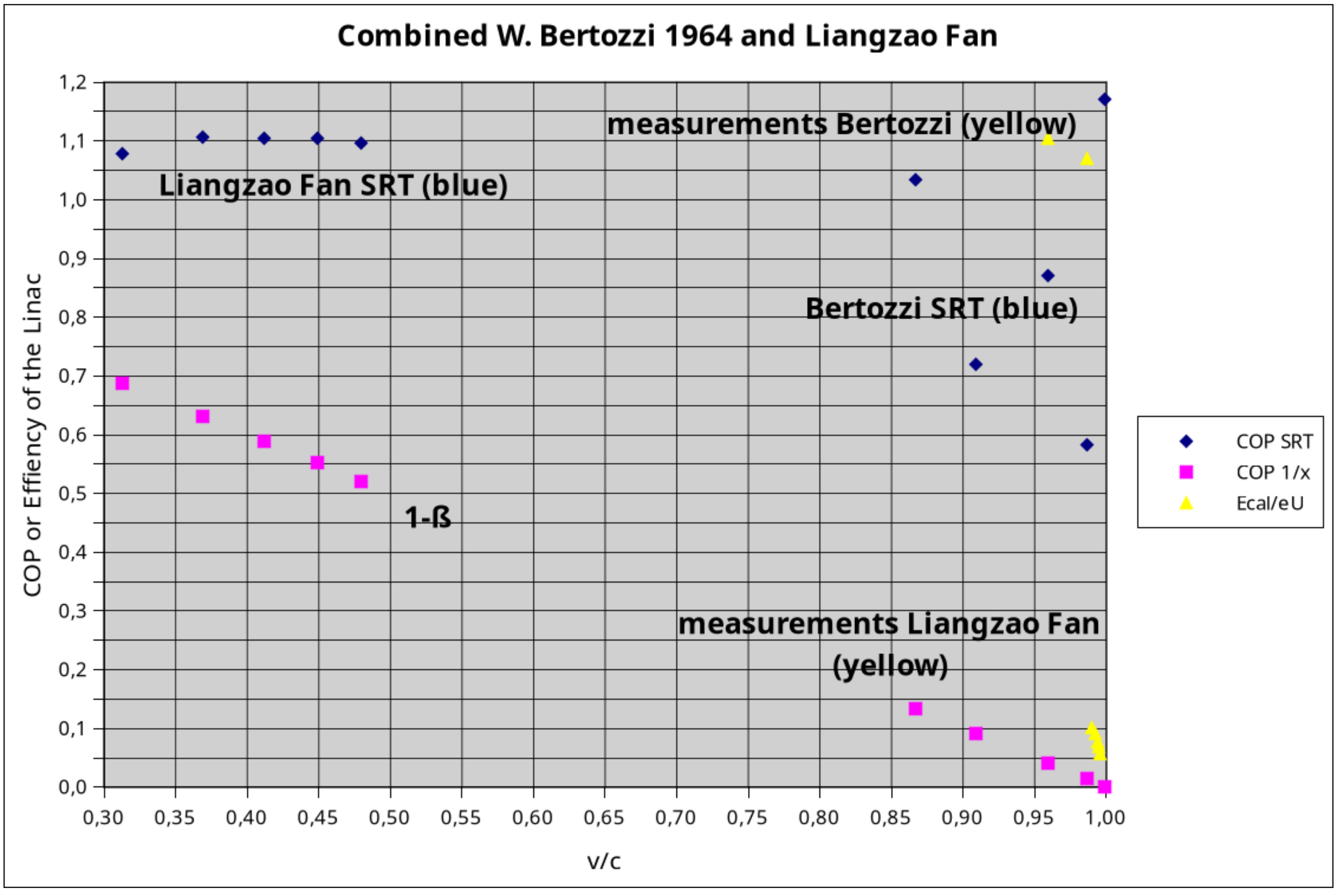

Figure 4 COP or efficiency measured and observed.

Most of the COP SRT is in overunity range. These points (blue) are calculated on the base of v/c obs.. Even constant 100% efficiency violates the law of energy conversation, because there are always inevitable losses. The yellow data was obtained by Liangzao Fan, and is 5 to 10%. So i recommend to measure E_{cal} with more experiments and not only in the high velocity range. In my opinion it is quite remarkable that SRT leads us to a perpetuum mobile if it should be possible to extract and use this overunity energies.

It is very suspicious that COP_{SRT} is scattering this way. But according to figure 2 this is not astonishing because a big variation of energy results in a small variation of v/c in the high energy area ($eU/mc^2 > 5$). So it would be very interesting to see what energy is theoretically needed for given (measured) velocities.

This is summarized in table 3 for the first 4 datapoints of Bertozzi.

Table 3 calculated energies for given velocities							
Bertozzi			1/x		SRT		Remark
v/c obs.	eU/mc²	U	eU/mc²	U	eU/mc²	U	
-	-	MV	-	MV	-	MV	
0,8675	0,978	0,5	0,766	0,4	1,010	0,5	
0,9097	1,957	1	1,179	0,6	1,408	0,7	v/c obs. obviously to low, should be around 0,94. See last row.
0,9596	2,935	1,5	2,781	1,4	2,554	1,3	
0,9866	8,806	4,5	8,619	4,4	5,129	2,6	←!
0,9410	1,957	1	1,867	0,955	1,955	0,999	adjusted v/c

In figure 5 this is visualized.

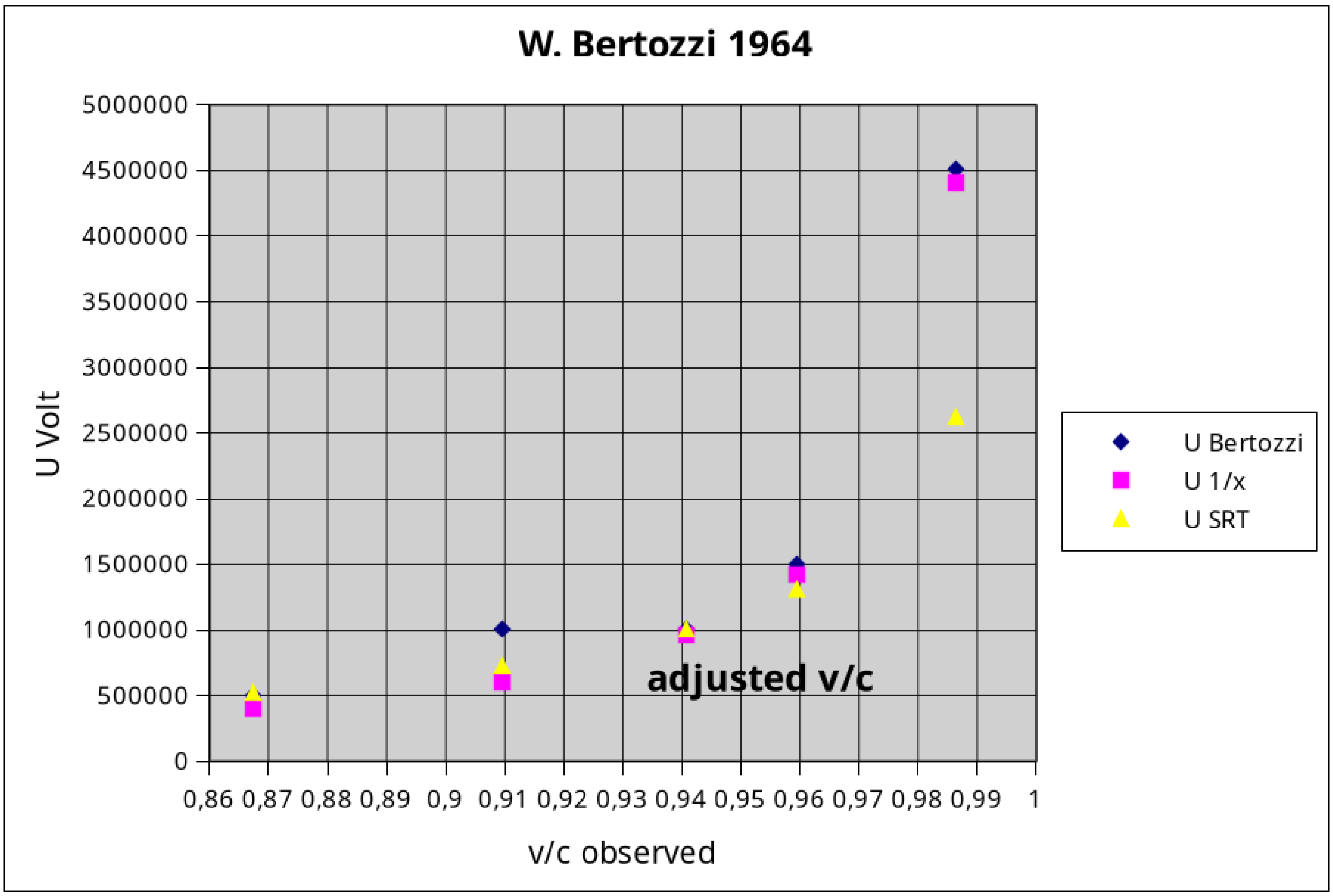

Fig. 5 Tension U for given velocities.

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As one can see in figure 5 U_{srt} is not able to turn the corner in the truest sense of the word. The bending of the Lorentz-curve is to weak in the area 0,95 < v/c < 0,99. For v/c < 0,95 U_{srt} is a good approximation of the measured values. In addition, if we adjust v/c = 0,91 to v/c_{adj} = 0,94 then the theoretical value of the energie or tension at that velocity match with the experimental ones as figure 5 shows.

§ 3 Experiment Zürich 1963[3]

Exact in the range of v/c ~ 0,986 an experiment in Zürich was made in 1963 to confirm special relativity. The setup was as follows:
First particles were rectilinearly accelerated to match a certain v/c of 0,9859. With this velocity a particle was able to cross a magnetic and subsequently an electric field with the lines of force perpendicular to the path of the particles. The magnetic radius was R_m = 0,5 m in a halfcircle and the electrical radius was R_e = 1 m in a quarter of a circle. Unfortenately there is no detailed description of this experiment except in some textbooks[3]. But this experiment is similar to that of A. H. Bucherer[4] (1908), F. T. Rogers[5] (1936) and M. M. Rogers[6] (1940).

In textbooks the given values are as follows in table 4. It was reported to be a high precission experiment in the range of 0,05% accuracy.

Table 4 Setup data Zürich 1963

R_m	R_e	B	E	U	v/c	Remark
m	m	Tesla	V/m	V	-	Unit
0,5	1	0,02	2955290	2530000	0,9859	Zürich
0,5006	1,0012	0,02	2955290	2540000	0,9859	SRT calculated
0,5003	1,0007	0,02	2955290	4180000	0,9859	1/x calculated

Obviously there are two eyecatchers: at first the ratio v/c and secondly the tension U to accelerate a particle to that velocity. If we compare that with the measurements of Bertozzi this becomes inconsistent! Bertozzi measured a velocity of v/c = 0,9866 with a tension of U = 4,5 MV! In the Zürich setup the tension is only 2,53 MV. But this is exactly the calculated value out of the relativistic $E_{kin\ srt}$ formula (2,54 MV)! So acceleration tension was apparently not measured, or Bertozzis data is wrong. If we assume v/c = 0,9859 to be correct (this is very likely because this is the velocity to traverse both the magnetic and the electric path), than U has to be adjusted to Bertozzis value and $E_{kin\ srt}$ is questionable.

This is now a real disaster. Both experiments had evidently confirmed special relativity theory at its best. But either Bertozzi is wrong, or measurements of Zürich are wrong, or both are wrong. In Bertozzis work Bertozzi published the photos of the measured ToF. And although this was a borderline measure (100 Mhz oscilloscope) they seems to be reliable as figure 1 and 3 show, except of one datapoint (v/c = 0,9097 wich is obviously to low). Additionally Liangzao Fan‘s date confirms these measurements on the low range of v/c.
But Bertozzi made a mistake. In his original paper on side 553 he plots the observed (v/c)² against the kinetic energy E_{kin} (dots) and additionally the relativistic prediction (dashed line). All seems fine, but he

forgot to recalculate the prediction out of the relativistic energy equation for specific velocities! If we take the original numbers of Bertozzi we obtain:

$$(v/c)^2 = 0{,}974 \text{ and } E_{kin}/m_0c^2 = 9.$$

But if we use the prediction of the relativistic equation to calculate the energy at $(v/c)^2 = 0{,}974$ then we obtain:

$$E_{kin\ srt}/m_0c^2 = (1-0{,}974)^{-1/2} - 1 = 5{,}2 \qquad (9)$$

So this is only 58% of Bertozzi's value. So what is true $E_{kin}/m_0c^2 = 9$ or $E_{kin\ srt}/m_0c^2 = 5{,}2$?

finally if we use the 1/x equation (3) we yield:

$$eU/m_0c^2 = \beta\cdot k\cdot c\cdot(1-\beta)^{-1}/s = 8{,}9 \qquad (10)$$

The last point measured by Bertozzi is omitted in figure 5 because a permanent acceleration was given to the particles (see Table 1 line *j*). So this is not really a ToF without acceleration. But if we compare the original photo's of the oscilloscope in Bertozzi's original work on page 553 than we see that there is practically no difference in the displacements on the photos *d* and *e* at energy levels of 9 and 30!

If we take a closer look to the photos on page 553 then we obtain:

Photo *d* : displacement ~ 2,90 cm this yields ToF = $2{,}840\cdot10^{-8}$ sec and v/c = 0,987 respective $(v/c)^2 = 0{,}974$ and
Photo *e* : displacement ~ 2,87 cm this yields ToF = $2{,}813\cdot10^{-8}$ sec and v/c = 0,996 respective $(v/c)^2 = 0{,}992$

The corresponding energies levels are:

Bertozzi	29,35
1/x	29,15 [calculated with equation (10)]
SRT	10,12 [calculated with equation (9)]

So again special relativity theory predicts only 34 % of the required energy and is unable to even begin to follow the measured data.

As mentioned above the relativistic expression has severe problems at roughly v/c = 0,95 and above. This is the bending area of the measured curve according to fig. 2 where big variations of energy results only in small variations of v/c. This fact was overlooked and covered the faulty behaviour of the Lorentz curve. The Lorentz curve was only painted without looking at discrete velocities and the connected energies to that velocities. Due to the asymptotical behaviour of the measured values and the Lorentz-curve every prediction is possible (only the shape of the approximation ‚fits' the measured data). This is also a consequense out of the ToF measurements.

§ 4 Summary

Before Bertozzi v/c was always calculated taking the ratio of E/(B·c). Where E denotes the electric field, B the magnetic field and c the velocity of light. Or the relativistic energy equation was used. Bertozzi was the first to **measure** the velocities of particles in a simple and expressive manner. The findings of the so called ToF (flight-time without acceleration during a fixed path of 8,4 m) were used to calculate v/c in depency of the required energy. Liangzao Fan repeated this experiment for lower v/c. Using these raw data and taking into account that ToF must asymptotically comes closer to a limit, namely s/c (s is the fixed path and c is the velocity of light), a 1/x function was found wich fits the measured data without problems even in the relativitic range. Of course there a to less data points, so there is a need for more data to refine this 1/x-function. Accidental the product of k and c is 1 m. As mentioned before Wilhelm Weber made a proposal in the 19th century (1844) that the impact of force or energy has a *(c-v)* function on charged particles. Just this proposal is a consequense of equation 1! It turned out that the SRT funktion $\gamma = [1-(v/c)^2]^{-1/2}$ wich H.A. Lorentz derived is absolutely not able to follow the measured values till v/c ~ 1, although it is a good approximation in the lower v/c range. Especially the relativistic energy equation $E_{kin\ srt} = (m(v) - m_0) \cdot c^2 = m_0 c^2(\gamma - 1)$ is very questionable.

References:

1) *William Bertozzi: Speed and Kinetic Energy of relativistic Electrons (pages 551 to 555)*

2) *Liangzao Fan: Three Experiments Challenging Einstein's Relativistic Mechanics and Traditional Electromagnetic Acceleration Theory (pages 1 to 10)*

3) *Metzler — Metzler Physik 2., durchgesehene Auflage 1992 Schroedel Schulbuchverlag*

4) *A. H. Bucherer — de.wikipedia.org/wiki/Kaufmann-Bucherer-Neumann-Experimente Kanalstrahlen Experimente*

5) *F. T. Rogers — The Precise Measurement of three Radium B Beta-Particles Energies May 1936*

6) *M.M. Rogers — A Determination of the Masses and Velocities of three Radium B Beta-Particles May 1940*